

# SURVEILLANCE REPORT



## Surveillance Report of Traumatic Brain Injury-related Emergency Department Visits, Hospitalizations, and Deaths

**UNITED STATES, 2014**



**Centers for Disease  
Control and Prevention**  
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## ACKNOWLEDGEMENTS

This Surveillance Report was prepared by staff from the National Center for Injury Prevention and Control (NCIPC), Centers for Disease Control and Prevention (CDC), U.S. Department of Health and Human Services, Atlanta, Georgia.

Contributors to this report included: Alexis B. Peterson, PhD<sup>1</sup>, Likang Xu, MD, MS<sup>2</sup>, Jill Daugherty, PhD<sup>1</sup>, Matthew J. Breiding, PhD<sup>1</sup>

<sup>1</sup>Division of Unintentional Injury Prevention, NCIPC, CDC

<sup>2</sup>Division of Analysis, Research, and Practice Integration, NCIPC, CDC.

Corresponding author: Alexis B. Peterson, [Apeterson4@cdc.gov](mailto:Apeterson4@cdc.gov)

This report focuses on traumatic brain injury (TBI) data collected from multiple sources. Data on TBI-related emergency department visits and hospitalizations were obtained from the 2014 Healthcare Cost and Utilization Project's Nationwide Emergency Department Sample and 2014 National Inpatient Sample, sponsored by the Agency for Healthcare Research and Quality. Data on TBI mortality were obtained from the National Vital Statistics System's 2014 multiple-cause-of-death files.

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### Disclaimer

The findings and conclusions in this report are those of the authors and do not necessarily represent the views of the Centers for Disease Control and Prevention.

## EXECUTIVE SUMMARY

In the United States (U.S.), traumatic brain injury (TBI) is a serious public health concern that results in death and disability for thousands of people each year. During 2013, TBIs were diagnosed in nearly 2.8 million of the 26 million injury-related emergency department visits, hospitalizations, and deaths that occurred in the U.S.<sup>1</sup>

This report describes 2014 national incidence estimates of TBI-related emergency department visits, hospitalizations, and deaths (TBI-EDHDs) by principal mechanism of injury, injury intent, and age as well as describes the trends in TBI incidence by principal mechanism from 2006-2014.\* TBI morbidity estimates were derived from the Healthcare Cost and Utilization Project's (HCUP) Nationwide Emergency Department Sample (NEDS) and National Inpatient Sample (NIS).^ HCUP is a suite of state-based administrative health care record databases that serves as a resource of encounter-level health care.<sup>2</sup> TBI mortality estimates were derived from the National Vital Statistics System^ (NVSS) which captures data for all deaths registered in all 50 U.S. states and the District of Columbia.<sup>3</sup> The 2014 data year was examined because 2014 was the final full-year in which ED visits, hospitalizations, and deaths were collected prior to the International Classification of Diseases diagnosis coding change that affected ED visits and hospitalizations.

### Key Findings:

#### TBI-related Emergency Department Visits, Hospitalizations, and Deaths

- In 2014, there were approximately 2.87 million TBI-EDHDs in the U.S., including over 837,000 of these health events among children.
- The number of TBI-EDHDs in 2014 represents a 53% increase from 2006, in which there were approximately 1.88 million TBI-EDHDs.

#### TBI-related Emergency Department (ED) Visits

- In 2014, there were approximately 2.5 million TBI-related ED visits in the U.S., including over 812,000 among children.
- Unintentional falls, being unintentionally struck by or against an object, and motor vehicle crashes were the most common mechanisms of injury contributing to a TBI diagnosis in the ED. These three principal mechanisms of injury accounted for 47.9%, 17.1%, and 13.2%, respectively, of all TBI-related ED visits.
- Rates of TBI-related ED visits per 100,000 population were highest among older adults aged  $\geq 75$  years (1,682.0), young children aged 0-4 years (1,618.6), and individuals aged 15-24 years (1,010.1).

#### TBI-related Hospitalizations

- In 2014, there were approximately 288,000 TBI-related hospitalizations in the U.S., including over 23,000 among children.
- Unintentional falls and motor vehicle crashes were the most common mechanisms of injury contributing to a TBI diagnosis in which the patient was hospitalized. These two principal mechanisms of injury accounted for 52.3% and 20.4%, respectively, of all TBI-related hospitalizations.
- Rates of TBI-related hospitalizations per 100,000 population were highest among older adults aged  $\geq 75$  years (470.6), those aged 65-74 years (145.5), and individuals aged 55-64 years (89.5).

#### TBI-related Deaths

- In 2014, there were 56,800 TBI-related deaths in the U.S., including 2,529 deaths among children.
- Intentional self-harm, unintentional falls, and motor vehicle crashes were the most common mechanisms of injury contributing to a TBI-related death. These three principal mechanisms of injury accounted for 32.5%, 28.1%, and 18.7%, respectively, of all TBI-related deaths.
- Rates of TBI-related deaths per 100,000 population were highest among older adults aged  $\geq 75$  years (78.5), those aged 65-74 years (24.7), and individuals aged 55-64 years (19.1).

### Trends in TBI incidence by principal mechanism, 2006-2014

- Age-adjusted rates of TBI-related ED visits increased 54% from 521.6 per 100,000 population in 2006 to 801.9 in 2014. An increase in age-adjusted rates occurred among nearly all of the major unintentional and intentional principal mechanism categories, including:
  - a 24% increase for TBI-related ED visits as a result of motor vehicle crashes (from 85.3 to 106);
  - an 80% increase for TBI-related ED visits as a result of falls (from 208.8 to 374.9);
  - a 58% increase for TBI-related ED visits as a result of being struck by or against an object (from 90.8 to 143.9);
  - a 60% increase for TBI-related ED visits as a result of intentional self-harm (from 0.5 to 0.8); and
  - an 18% increase for TBIs as a result of assault (from 57.6 to 67.8).
- While the number of TBI-related hospitalizations increased from 2006 to 2014, age-adjusted rates of TBI-related hospitalizations decreased by nearly 8% during that same period (from 92.2 to 84.9 per 100,000). This decrease coincides with a 34% decrease in the age-adjusted rate of TBI-related hospitalizations attributable to motor vehicle crashes (27.6 in 2006 to 18.1 in 2014).
- While the number of TBI-related deaths increased from 2006 to 2014, age-adjusted rates decreased by 6% during that time period (from 17.9 in 2006 to 16.8 per 100,000 in 2014). This decrease coincides with a large decrease in the age-adjusted rate of TBI-related deaths attributable to motor vehicle crashes (5.4 in 2006 to 3.3 in 2014).

### Limitations

- Findings do not include individuals who did not seek care for their TBI or patients who sought care outside of a hospital setting (e.g., primary care, urgent care, specialty care).
- Although some codes included in the TBI surveillance definition are indicative of a more severe injury, the analysis presented in this report did not differentiate by severity of injury.
- While TBI estimates can be disaggregated into broad categories of mechanism of injury, these breakdowns do not allow for a more specific accounting of the causes of TBI-related injuries and limit the specificity of conclusions that can be drawn regarding primary causes of TBI-EDHDs.
- For a sizable portion of cases there is insufficient information in the record to support assignment of a contributing mechanism of injury or injury intent. As a result, estimates of TBI-EDHDs by mechanism of injury and injury intent are underestimates.
- Trends of TBI-EDHDs are reported for the most recent years in which all data are available (ED visits, hospitalizations, and deaths) prior to the International Classification of Diseases diagnosis coding change. Trends of TBI-EDHDs occurring prior to 2006 are described online.<sup>¶</sup>

### Conclusions

- Decreases in TBI-related hospitalizations and deaths as a result of motor vehicle crashes indicate significant progress in motor vehicle safety.
- Falls were the leading cause of injury for TBI-EDHDs in 2014, and over half of TBIs attributed to falls were in the youngest (0-4 years) and oldest ( $\geq 75$  years) age groups, suggesting a need to intensify efforts related to fall prevention, particularly in these age groups.
- During the period of 2006-2014, rates of TBI-related deaths due to intentional self-harm increased 17%. This mirrors the increase in suicide rates overall in the U.S.,<sup>4</sup> suggesting the need for expansion of comprehensive and coordinated suicide prevention efforts.<sup>#</sup>

\* Note: TBI morbidity and mortality identification and classification are described in the "Methods" section

^ Note: Data sources analyzed for TBI morbidity and mortality and data exclusions described in the "Methodological Appendix"

¶ <https://www.cdc.gov/traumaticbraininjury/data/index.html>

# <https://www.cdc.gov/violenceprevention/pdf/suicideTechnicalPackage.pdf>

## METHODS

For TBI-related ED visits and hospitalizations, cases were identified using codes from the International Classification of Diseases, Ninth Edition, Clinical Modification (ICD-9-CM) based on an established surveillance definition for TBI morbidity.<sup>5</sup> Cases were included and classified as TBI-related if any of the following ICD-9-CM diagnosis codes, regardless of position (i.e. both primary and secondary diagnoses), were included in the health record. These codes included:

- 800: fracture of vault of skull;
- 801: fracture of the base of skull;
- 803: other and unqualified skull fractures;
- 804: multiple fractures involving skull or face with other bones;
- 850: concussion;
- 851: cerebral laceration and contusion;
- 852: subarachnoid, subdural, and extradural hemorrhage, following injury;
- 853: other and unspecified intracranial hemorrhage following injury;
- 854.0, 854.1: intracranial injury of other and unspecified nature;
- 950.1–950.3: injury to the optic nerve and pathways;
- 959.01: unspecified head injury; and
- 995.55: shaken infant syndrome.

HCUP's NEDS and NIS data were weighted to provide national level estimates of annual numbers and rates per 100,000 population. Weighting procedures used during statistical analysis are referenced in the Methodological Appendix. Non-overlapping confidence intervals were used to compare annual numbers and rates. Each rate and its surrounding 95% confidence interval were based on U.S. bridged-race population estimates of the resident population.<sup>6</sup> U.S. census population estimates for the year 2000 were used as the standard for age-adjusted rates by direct method.<sup>7</sup> If the relative standard error was >30% or the standard error = 0, then the value of the estimate was considered unreliable and was not reported.

For TBI-related deaths, cases were identified using codes from the International Classification of Diseases, Tenth Revision, (ICD-10) based on an established surveillance definition for TBI mortality<sup>5</sup>. Cases were included and classified as a TBI-related death if any of the following ICD-10 codes, regardless of position, were included in the NVSS mortality record. These codes included:

- S01: open wound of the head;
- S02.0, S02.1, S02.3, S02.7–S02.9: fracture of the skull and facial bones;
- S04.0: injury to optic nerve and pathways;
- S06: intracranial injury;
- S07.0, S07.1, S07.8, S07.9: crushing injury of head;
- S09.7–S09.9: other unspecified injuries of head;
- T90.1, T90.2, T90.4, T90.5, T90.8, T90.9: sequelae of injuries of head.

Data on TBI-EDHDs were stratified by age, principal mechanism of injury, and injury intent. Age groups assessed included ages 0-4, 5-14, 15-24, 25-34, 35-44, 45-54, 55-64, 65-74, and ≥75 years.

Estimates of pediatric TBI-EDHDs were calculated separately by grouping TBI-EDHDs in those  $\leq 17$  years of age. Principal mechanisms of injury assessed included motor vehicle crashes, falls, being struck by or against an object, intentional self-harm, assault/homicide, mechanism unspecified, and other/no mechanism specified. Injury intent was categorized as unintentional (motor vehicle crashes, falls, being struck by or against an object, mechanism unspecified), intentional (self-harm and assault/homicide), and undetermined intent. Estimates of TBI-EDHDs attributable to self-harm were suppressed for the 0-4, 5-14, and  $\leq 17$  year age groups as suicidal intent in children aged  $<10$  years remains unclear.<sup>8</sup>

To assess TBI-related ED visits and hospitalizations by principal mechanism of injury and injury intent we utilized CDC's recommended framework for grouping external cause of injury codes (E-codes) using ICD-9-CM.<sup>9</sup> E-codes analyzed included E800-E966 and E968-E999. E-codes for an injury-related activity (E000), place of injury occurrence (E001-E030), or perpetrator of abuse (E967) were excluded from this analysis. First-listed valid E-code was used in this study, as it is assumed the first listed code is the principal mechanism of injury<sup>10</sup> for the diagnosed TBI. For TBI-related deaths, principal mechanisms of injury and injury intent were categorized based on the CDC-recommended E-code mortality matrix for ICD-10.<sup>11</sup> Trends for TBI-EDHDs encountered during 2006 to 2014 were assessed by collapsing national level estimated counts of each health event attributable to relevant principal mechanisms of injury and injury intents (i.e. E800-E966 and E968-E999 codes assessed) for each data year.



# TABLES



## Traumatic Brain Injury-related Emergency Department Visits, Hospitalizations, and Deaths

**UNITED STATES, 2014**

## TABLES AND FIGURES

**Table 1:** Estimated number and rate of traumatic brain injury–related emergency department visits, hospitalizations, and deaths, by age group — United States, 2014

**Table 2:** Estimated number and rate of traumatic brain injury–related emergency department visits, by age group and mechanism of injury — United States, 2014

**Table 3:** Estimated number and rate of traumatic brain injury–related hospitalizations, by age group and mechanism of injury — United States, 2014

**Table 4:** Number and rate of traumatic brain injury-related deaths, by age group and mechanism of injury — United States, 2014

**Figure 1:** Estimated number of traumatic brain injury-related emergency department visits, hospitalizations, and deaths by year — United States, 2006-2014

**Figure 2A:** Estimated age-adjusted rates, per 100,000 population, of traumatic brain injury–related emergency department visits, by year and mechanism of injury — United States, 2006-2014

**Figure 2B:** Estimated number of traumatic brain injury–related emergency department visits, by year and mechanism of injury — United States, 2006-2014

**Figure 3A:** Estimated age-adjusted rates, per 100,000 population, of traumatic brain injury–related hospitalizations, by year and mechanism of injury — United States, 2006-2014

**Figure 3B:** Estimated number of traumatic brain injury–related hospitalizations, by year and mechanism of injury — United States, 2006-2014

**Figure 4A:** Age-adjusted rates, per 100,000 population, of traumatic brain injury–related deaths, by year and mechanism of injury — United States, 2006-2014

**Figure 4B:** Number of traumatic brain injury–related deaths, by year and mechanism of injury — United States, 2006-2014



TABLE 1: ESTIMATED NUMBER AND RATE OF TRAUMATIC BRAIN INJURY–RELATED EMERGENCY DEPARTMENT VISITS, HOSPITALIZATIONS, AND DEATHS, BY AGE GROUP, 2014

Age Group	Emergency Department Visits		Hospitalizations		Deaths		Total	
	No.	Rate (95% CI)*	No.	Rate (95% CI)*	No.	Rate (95% CI)*	No.	Rate (95% CI)*
0-17	812,237	1,103.9 (1,011.7-1,196.1)	23,075	31.4 (27.6-35.1)	2,529	3.4 (3.3-3.6)	837,841	1,138.7 (1,046.6-1,230.9)
0-4	321,740	1,618.6 (1,452.6-1,784.6)	8,970	45.1 (38.5-51.7)	721	3.6 (3.4-3.9)	331,431	1,667.4 (1,501.5-1,833.2)
5-14	340,274	826.1 (758.4-893.9)	8,245	20.0 (17.1-22.9)	774	1.9 (1.7-2.0)	349,293	848.0 (780.3-915.7)
15-24	443,920	1,010.1 (957.6-1,062.5)	26,420	60.1 (55.3-64.9)	6,311	14.4 (14.0-14.7)	476,651	1,084.6 (1,032.0-1,137.2)
25-34	287,452	661.4 (623.0-699.9)	25,480	58.6 (54.1-63.2)	6,371	14.7 (14.3-15.0)	319,303	734.7 (696.0-773.4)
35-44	213,982	529.1 (498.7-559.4)	20,935	51.8 (48.1-55.4)	5,545	13.7 (13.3-14.1)	240,462	594.5 (564.0-625.1)
45-54	227,341	523.9 (493.9-553.8)	30,740	70.8 (66.4-75.2)	7,336	16.9 (16.5-17.3)	265,417	611.6 (581.4-641.8)
55-64	198,020	494.6 (466.7-522.6)	35,840	89.5 (84.8-94.2)	7,652	19.1 (18.7-19.5)	241,512	603.3 (575.0-631.5)
65-74	166,135	629.7 (592.7-666.7)	38,395	145.5 (139.2-151.8)	6,526	24.7 (24.1-25.3)	211,056	800.0 (762.5-837.5)
75+	333,528	1,682.0 (1,566.1-1,797.9)	93,320	470.6 (452.8-488.5)	15,562	78.5 (77.2-79.7)	442,410	2,231.1 (2,114.0-2,348.3)
Total	2,532,393	794.9 (752.6-837.3)	288,345	90.5 (86.5-94.6)	56,800	17.8 (17.7-18.0)	2,877,538	903.3 (860.8-945.7)
Adjusted <sup>†</sup>		804.8 (784.6-825.0)		86.1 (84.3-88.0)		17.0 (16.9-17.2)		907.9 (887.6-928.3)

## Key Findings:

- In 2014, there were approximately 2.87 million TBI-EDHDs in the United States, including over 837,000 occurring among children. This includes:
  - Approximately 2.53 million TBI-related ED visits, including over 812,000 occurring among children.
  - Approximately 288,000 TBI-related hospitalizations, including over 23,000 occurring among children.
  - 56,800 TBI-related deaths, including 2,529 occurring among children
- The highest rates of total TBI-EDHDs were seen among older adults aged ≥75 years (2,231.1 per 100,000 population), children aged 0-4 years (1,667.4), and individuals aged 15-24 years (1,010.1).
- Rates of TBI-related ED visits were highest among those aged ≥75 years (1,682.0), 0-4 years (1,618.6), and 15-24 years (1,010.1).
- Individuals aged 15-24 had the highest number of TBI-related ED visits in 2014, accounting for 17.5% (N=443,920) of all TBI-related ED visits for the year.
- Rates of TBI-related hospitalizations were highest among older adults aged ≥75 years (470.6), adults aged 65-74 years (145.5) and those aged 55-64 years (89.5).
- Those aged ≥75 years had the highest rate (78.5) of TBI-related deaths out of all of the age groups, followed by individuals aged 65-74 years (24.7) and 55-64 years (19.1).
- Adults aged ≥75 years accounted for the highest proportion of all TBI-related hospitalizations (32.4%; N=93,320) and deaths (27.4%; N=15,562) among all the age groups analyzed.

## SOURCES

For emergency department visits, Healthcare Cost and Utilization Project's (HCUP) Nationwide Emergency Department Sample; for hospitalizations, HCUP's Nationwide Inpatient Sample; for deaths, CDC's National Vital Statistics System.

Abbreviations: CI = confidence interval. \*Per 100,000 population. <sup>†</sup>Age-adjusted to the 2000 U.S. standard population.

TABLE 2: ESTIMATED NUMBER AND RATE OF TRAUMATIC BRAIN INJURY–RELATED EMERGENCY DEPARTMENT VISITS, BY AGE GROUP AND MECHANISM OF INJURY, 2014

Age Group	Motor vehicle crashes		Unintentional falls <sup>††</sup>		Unintentionally struck by or against an object		Other unintentional injury, mechanism unspecified <sup>‡‡</sup>		Intentional self-harm		Assault		Other or no mechanism specified <sup>§§</sup>	
	No.	Rate (95% CI)*	No.	Rate (95% CI)*	No.	Rate (95% CI)*	No.	Rate (95% CI)*	No.	Rate (95% CI)*	No.	Rate (95% CI)*	No.	Rate (95% CI)*
<b>0-17</b>	47,138	64.1 (59.5-68.6)	397,190	539.8 (487.7-592.0)	229,236	311.6 (285.1-338.0)	55,785	75.8 (69.9-81.8)	##	##	24,360	33.1 (30.5-35.7)	57,983	78.8 (51.1-106.5)
<b>0-4</b>	5,464	27.5 (24.3-30.6)	230,776	1,161.0 (1,035.5-1,286.5)	53,436	268.8 (241.6-296.1)	12,007	60.4 (52.9-67.9)	##	##	674	3.4 (2.8-4.0)	19,360	97.4 (56.1-138.7)
<b>5-14</b>	19,785	48.0 (43.8-52.3)	133,084	323.1 (293.9-352.4)	120,839	293.4 (267.3-319.4)	30,656	74.4 (68.7-80.1)	##	##	9,690	23.5 (21.3-25.8)	26,022	63.2 (41.6-84.7)
<b>15-24</b>	103,892	236.4 (220.8-252.0)	96,568	219.7 (207.0-232.4)	106,679	242.7 (227.1-258.3)	37,118	84.5 (79.6-89.3)	870	2.0 (1.6-2.3)	65,399	148.8 (139.1-158.5)	33,395	76.0 (56.8-95.2)
<b>25-34</b>	71,641	164.8 (152.9-176.8)	70,210	161.6 (151.9-171.2)	44,404	102.2 (95.6-108.8)	22,360	51.5 (47.9-55.0)	650	1.5 (1.2-1.8)	57,213	131.6 (122.3-141.0)	20,974	48.3 (35.1-61.5)
<b>35-44</b>	44,108	109.1 (101.0-117.1)	68,830	170.2 (160.1-180.3)	32,479	80.3 (75.0-85.6)	17,541	43.4 (40.4-46.3)	421	1.0 (0.8-1.3)	34,100	84.3 (78.1-90.5)	16,503	40.8 (29.7-52.0)
<b>45-54</b>	40,020	92.2 (85.4-99.0)	95,127	219.2 (206.5-231.9)	30,495	70.3 (65.4-75.2)	17,808	41.0 (38.2-43.8)	247	0.6 (0.4-0.7)	27,682	63.8 (58.7-68.8)	15,962	36.8 (27.1-46.5)
<b>55-64</b>	27,193	67.9 (62.9-73.0)	112,460	280.9 (264.3-297.5)	20,408	51.0 (47.4-54.5)	12,928	32.3 (30.0-34.6)	105	0.3 (0.2-0.4)	11,538	28.8 (26.5-31.2)	13,387	33.4 (24.7-42.1)
<b>65-74</b>	13,829	52.4 (48.4-56.5)	120,327	456.1 (428.3-483.8)	11,937	45.2 (41.7-48.8)	7,077	26.8 (24.6-29.0)	¶¶	¶¶	2,893	11.0 (9.7-12.2)	10,051	38.1 (27.8-48.4)
<b>75+</b>	8,176	41.2 (37.7-44.8)	286,031	1,442.5 (1,339.3-1,545.6)	13,270	66.9 (60.4-73.4)	7,440	37.5 (34.0-41.1)	¶¶	¶¶	1,260	6.4 (5.4-7.3)	17,318	87.3 (65.1-109.6)
<b>Total</b>	334,109	104.9 (98.0-111.8)	1,213,412	380.9 (358.5-403.3)	433,947	136.2 (127.3-145.2)	164,935	51.8 (48.9-54.6)	2,567	0.8 (0.7-0.9)	210,450	66.1 (61.7-70.4)	172,974	54.3 (40.2-68.4)
<b>Adjusted<sup>¶</sup></b>		106.1 (102.8-109.3)		378.6 (366.4-390.7)		142.8 (137.8-147.8)		53.1 (51.7-54.6)		0.8 (0.8-0.9)		68.1 (65.8-70.3)		55.3 (49.3-61.3)

## Key Findings:

- The most common principal mechanisms of injury were unintentional falls (378.6 per 100,000 population, age-adjusted), being unintentionally struck by or against an object (142.8), and motor vehicle crashes (106.1). During 2014, these top three principal mechanisms of injury accounted for 47.9%, 17.1%, and 13.2%, respectively, of all TBI-related ED visits.
- TBI-related ED visits attributable to falls were most common among older adults aged ≥75 years (rate of 1,442.5), young children aged 0-4 years (1,161.0), and individuals 65-74 years (456.1).
- Rates of TBI-related ED visits attributable to being unintentionally struck by or against an object were highest among those aged 5-14 years (293.4), 0-4 years (268.8), and 15-24 years (242.7).
- Rates of TBI-related ED visits attributable to motor vehicle crashes were highest among those aged 15-24 years (236.4), 25-34 years (164.8), and 35-44 years (109.1).
- Among children aged 0-17 years, analyzed separately, the most common principal mechanisms of injury for TBI-related ED visits were falls (rate of 539.8), being struck by or against an object (311.6), and motor vehicle crashes (64.1).

## SOURCES

Healthcare Cost and Utilization Project's (HCUP) Nationwide Emergency Department Sample.

Abbreviations: CI = confidence interval. \*Per 100,000 population. ††Includes falls of undetermined intent to maintain consistency with past data releases. ‡‡ E-codes specify that the injury was unintentional but do not specify the actual mechanism of injury. §§Includes TBIs in which the intent was not determined as well as those due to legal intervention or war. Includes TBIs in which no mechanism was specified in the record. Does not include falls of undetermined intent. ¶¶Estimates suppressed for the 0-4, 5-14, and 0-17 age groups. ¶¶¶The relative standard error was >30% or the standard error = 0. ¶Age-adjusted to the 2000 U.S. standard population.

TABLE 3: ESTIMATED NUMBER AND RATE OF TRAUMATIC BRAIN INJURY–RELATED HOSPITALIZATIONS, BY AGE GROUP AND MECHANISM OF INJURY, 2014

Age Group	Motor vehicle crashes		Unintentional falls <sup>††</sup>		Unintentionally struck by or against an object		Other unintentional injury, mechanism unspecified <sup>††</sup>		Intentional self-harm		Assault		Other or no mechanism specified <sup>§§</sup>	
	No.	Rate (95% CI)*	No.	Rate (95% CI)*	No.	Rate (95% CI)*	No.	Rate (95% CI)*	No.	Rate (95% CI)*	No.	Rate (95% CI)*	No.	Rate (95% CI)*
0-17	5,830	7.9 (6.9-9.0)	7,935	10.8 (9.4-12.2)	1,985	2.7 (2.3-3.1)	3,135	4.3 (3.6-4.9)	##	##	1,535	2.1 (1.7-2.5)	2,595	3.5 (2.6-4.5)
0-4	870	4.4 (3.4-5.4)	4,700	23.6 (20.1-27.2)	510	2.6 (2.0-3.2)	785	3.9 (3.1-4.8)	##	##	960	4.8 (3.7-5.9)	1,140	5.7 (4.1-7.4)
5-14	2,395	5.8 (4.8-6.8)	2,270	5.5 (4.7-6.3)	980	2.4 (1.9-2.9)	1,435	3.5 (2.8-4.2)	##	##	195	0.5 (0.3-0.6)	955	2.3 (1.6-3.1)
15-24	12,925	29.4 (26.5-32.3)	3,910	8.9 (8.0-9.8)	1,070	2.4 (2.1-2.8)	3,060	7.0 (6.2-7.7)	280	0.6 (0.5-0.8)	3,125	7.1 (6.3-7.9)	2,050	4.7 (3.7-5.7)
25-34	11,050	25.4 (22.9-27.9)	4,470	10.3 (9.3-11.2)	635	1.5 (1.2-1.7)	2,600	6.0 (5.3-6.7)	440	1.0 (0.8-1.2)	4,320	9.9 (8.8-11.0)	1,965	4.5 (3.6-5.5)
35-44	7,305	18.1 (16.2-19.9)	5,640	13.9 (12.8-15.0)	610	1.5 (1.2-1.8)	2,255	5.6 (4.9-6.2)	340	0.8 (0.6-1.0)	2,865	7.1 (6.3-7.9)	1,920	4.7 (3.9-5.6)
45-54	8,490	19.6 (17.6-21.5)	12,010	27.7 (26.0-29.4)	685	1.6 (1.3-1.9)	3,140	7.2 (6.5-8.0)	350	0.8 (0.6-1.0)	3,290	7.6 (6.8-8.4)	2,775	6.4 (5.4-7.4)
55-64	7,280	18.2 (16.5-19.9)	18,490	46.2 (43.8-48.6)	765	1.9 (1.6-2.2)	3,165	7.9 (7.1-8.7)	145	0.4 (0.2-0.5)	1,780	4.4 (3.9-5.0)	4,215	10.5 (9.2-11.8)
65-74	4,485	17.0 (15.3-18.7)	25,235	95.6 (91.4-99.9)	790	3.0 (2.5-3.5)	2,180	8.3 (7.4-9.1)	85	0.3 (0.2-0.5)	535	2.0 (1.6-2.4)	5,085	19.3 (17.2-21.4)
75+	3,965	20.0 (18.0-22.0)	74,005	373.2 (358.3-388.1)	1,045	5.3 (4.5-6.0)	2,550	12.9 (11.7-14.1)	70	0.4 (0.2-0.5)	325	1.6 (1.2-2.0)	11,360	57.3 (51.4-63.2)
Total	58,765	18.4 (16.9-20.0)	150,730	47.3 (45.5-49.1)	7,090	2.2 (2.1-2.4)	21,170	6.6 (6.2-7.1)	1,730	0.5 (0.5-0.6)	17,395	5.5 (5.0-5.9)	31,465	9.9 (8.8-11.0)
Adjusted <sup>¶</sup>		18.2 (17.4-18.9)		43.9 (42.9-45.0)		2.2 (2.1-2.3)		6.5 (6.2-6.7)		0.6 (0.5-0.6)		5.5 (5.3-5.8)		9.3 (8.8-9.8)

## Key Findings:

- Unintentional falls accounted for the highest age-adjusted rate (43.9 per 100,000 population) and proportion (52.3%; N=150,730) of all TBI-related hospitalizations. Rates for TBI-related hospitalizations attributable to unintentional falls were most prominent among older adults aged ≥75 years (373.2), 65-74 years (95.6), and 55-64 years (46.2).
- Motor vehicle crashes were the second most common mechanism of injury with an age-adjusted rate of 18.2 and accounted for 20.4% (N=58,765) of TBI-related hospitalizations. Age groups with the highest rate of motor vehicle crashes leading to a TBI-related hospitalization were 15-24 years (29.4), 25-34 years (25.4), and 45-54 years of age (19.6).
- Among children aged 0-17 years, analyzed separately, the most common principal mechanisms of injury for TBI-related hospitalizations were falls (rate of 10.8) and motor vehicle crashes (7.9).

## SOURCES

Healthcare Cost and Utilization Project's (HCUP) Nationwide Inpatient Sample.

Abbreviations: CI = confidence interval. \*Per 100,000 population. <sup>††</sup>Includes falls of undetermined intent to maintain consistency with past data releases. <sup>‡‡</sup>E-codes specify that the injury was unintentional but do not specify the actual mechanism of injury. <sup>§§</sup>Includes TBIs in which the intent was not determined as well as those due to legal intervention or war. Includes TBIs in which no mechanism was specified in the record. Does not include falls of undetermined intent. <sup>###</sup>Estimates suppressed for the 0-4, 5-14, and 0-17 age groups. <sup>¶¶</sup>The relative standard error was >30% or the standard error = 0. <sup>¶</sup>Age-adjusted to the 2000 U.S. standard population.

TABLE 4: NUMBER AND RATE OF TRAUMATIC BRAIN INJURY-RELATED DEATHS, BY AGE GROUP AND MECHANISM OF INJURY — UNITED STATES, 2014

Age Group	Motor vehicle crashes		Unintentional falls <sup>††</sup>		Unintentionally struck by or against an object		Other unintentional injury, mechanism unspecified <sup>††</sup>		Intentional self-harm		Homicide		Other or no mechanism specified <sup>§§</sup>	
	No.	Rate (95% CI)*	No.	Rate (95% CI)*	No.	Rate (95% CI)*	No.	Rate (95% CI)*	No.	Rate (95% CI)*	No.	Rate (95% CI)*	No.	Rate (95% CI)*
<b>0-17</b>	931	1.3 (1.2-1.3)	48	0.1 (0.0-0.1)	52	0.1 (0.1-0.1)	308	0.4 (0.4-0.5)	##	##	611	0.8 (0.8-0.9)	61	0.1 (0.1-0.1)
<b>0-4</b>	187	0.9 (0.8-1.1)	19	0.1 (0.1-0.1)	27	0.1 (0.1-0.2)	136	0.7 (0.6-0.8)	##	##	322	1.6 (1.4-1.8)	30	0.2 (0.1-0.2)
<b>5-14</b>	326	0.8 (0.7-0.9)	16	0.0 (0.0-0.1)	19	0.0 (0.0-0.1)	110	0.3 (0.2-0.3)	##	##	117	0.3 (0.2-0.3)	19	0.0 (0.0-0.1)
<b>15-24</b>	2,419	5.5 (5.3-5.7)	95	0.2 (0.2-0.3)	21	0.0 (0.0-0.1)	344	0.8 (0.7-0.9)	2,171	4.9 (4.7-5.1)	1,165	2.7 (2.5-2.8)	96	0.2 (0.2-0.3)
<b>25-34</b>	1,960	4.5 (4.3-4.7)	175	0.4 (0.3-0.5)	34	0.1 (0.1-0.1)	345	0.8 (0.7-0.9)	2,622	6.0 (5.8-6.3)	1,110	2.6 (2.4-2.7)	125	0.3 (0.2-0.3)
<b>35-44</b>	1,402	3.5 (3.3-3.6)	328	0.8 (0.7-0.9)	41	0.1 (0.1-0.1)	388	1.0 (0.9-1.1)	2,502	6.2 (5.9-6.4)	732	1.8 (1.7-1.9)	152	0.4 (0.3-0.4)
<b>45-54</b>	1,484	3.4 (3.2-3.6)	908	2.1 (2.0-2.2)	62	0.1 (0.1-0.2)	618	1.4 (1.3-1.5)	3,334	7.7 (7.4-7.9)	633	1.5 (1.3-1.6)	297	0.7 (0.6-0.8)
<b>55-64</b>	1,287	3.2 (3.0-3.4)	1,674	4.2 (4.0-4.4)	70	0.2 (0.1-0.2)	585	1.5 (1.3-1.6)	3,233	8.1 (7.8-8.4)	410	1.0 (0.9-1.1)	393	1.0 (0.9-1.1)
<b>65-74</b>	797	3.0 (2.8-3.2)	2,324	8.8 (8.5-9.2)	60	0.2 (0.2-0.3)	504	1.9 (1.7-2.1)	2,244	8.5 (8.2-8.9)	241	0.9 (0.8-1.0)	356	1.3 (1.2-1.5)
<b>75+</b>	794	4.0 (3.7-4.3)	10,400	52.4 (51.4-53.5)	44	0.2 (0.2-0.3)	859	4.3 (4.0-4.6)	2,212	11.2 (10.7-11.6)	174	0.9 (0.7-1.0)	1,079	5.4 (5.1-5.8)
<b>Total</b>	10,656	3.3 (3.3-3.4)	15,939	5.0 (4.9-5.1)	378	0.1 (0.1-0.1)	3,889	1.2 (1.2-1.3)	18,485	5.8 (5.7-5.9)	4,906	1.5 (1.5-1.6)	2,547	0.8 (0.8-0.8)
<b>Adjusted<sup>¶</sup></b>		3.3 (3.2-3.4)		4.6 (4.6-4.7)		0.1 (0.1-0.1)		1.2 (1.1-1.2)		5.5 (5.5-5.6)		1.6 (1.5-1.6)		0.7 (0.7-0.8)

## Key Findings:

- Intentional self-harm accounted for the highest age-adjusted rate (5.5 per 100,000 population, age-adjusted) and proportion (32.5%) of all TBI-related deaths in the U.S.
- Unintentional falls were not far behind with an age-adjusted rate of 4.6 and accounted for 28.1% of all TBI-related deaths.
- Motor vehicle crashes were the third most common cause of TBI-related deaths in 2014, with an age-adjusted rate of 3.3 and contributing to 10,656 deaths.
- Rates of TBI-related deaths attributable to intentional self-harm were highest among those aged ≥75 years (11.2), 65-74 years (8.5), and 55-64 years (8.1). The same age groups (≥75 years, 65-74 years, and 55-64 years) had the highest rate of TBI-related deaths caused by unintentional falls, with rates of 52.4, 8.8, and 4.2, respectively.
- Rates of TBI-related deaths attributable to motor vehicle crashes were highest among those aged 15-24 years (5.5), 25-34 years (4.5), and older adults aged ≥75 years (4.0).
- The top principal mechanism of injury leading to TBI-related death among young children and adolescents aged 0-17 years was motor vehicle crashes (1.3).

## SOURCES

CDC's National Vital Statistics System.

Abbreviations: CI = confidence interval. \*Per 100,000 population. <sup>††</sup>Includes falls of undetermined intent to maintain consistency with past data releases. <sup>‡‡</sup>E-codes specify that the injury was unintentional but do not specify the actual mechanism of injury. <sup>§§</sup>Includes TBIs in which the intent was not determined as well as those due to legal intervention or war. Includes TBIs in which no mechanism was specified in the record. Does not include falls of undetermined intent. <sup>¶¶</sup> Counts suppressed for the 0-4, 5-14, and 0-17 age groups. <sup>¶</sup>Age-adjusted to the 2000 U.S. standard population.

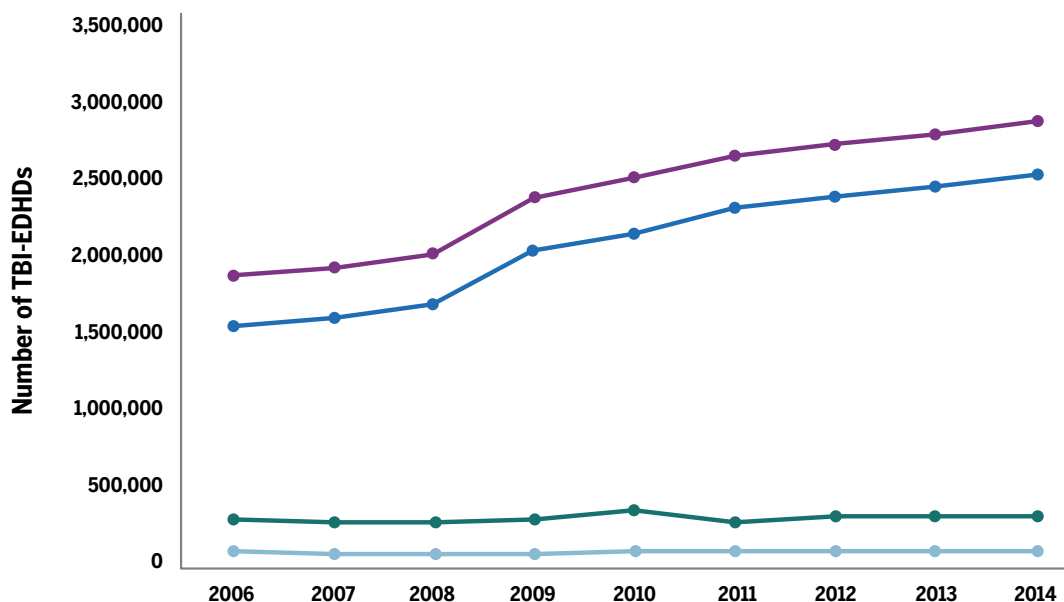
# FIGURES



## Trends in Traumatic Brain Injury Incidence by Principal Mechanism of Injury and Injury Intent

UNITED STATES, 2006-2014

**FIGURE 1: ESTIMATED NUMBER OF TRAUMATIC BRAIN INJURY-RELATED EMERGENCY DEPARTMENT VISITS, HOSPITALIZATIONS, AND DEATHS (TBI-EDHDS) BY YEAR, 2006-2014**



### Key Findings:

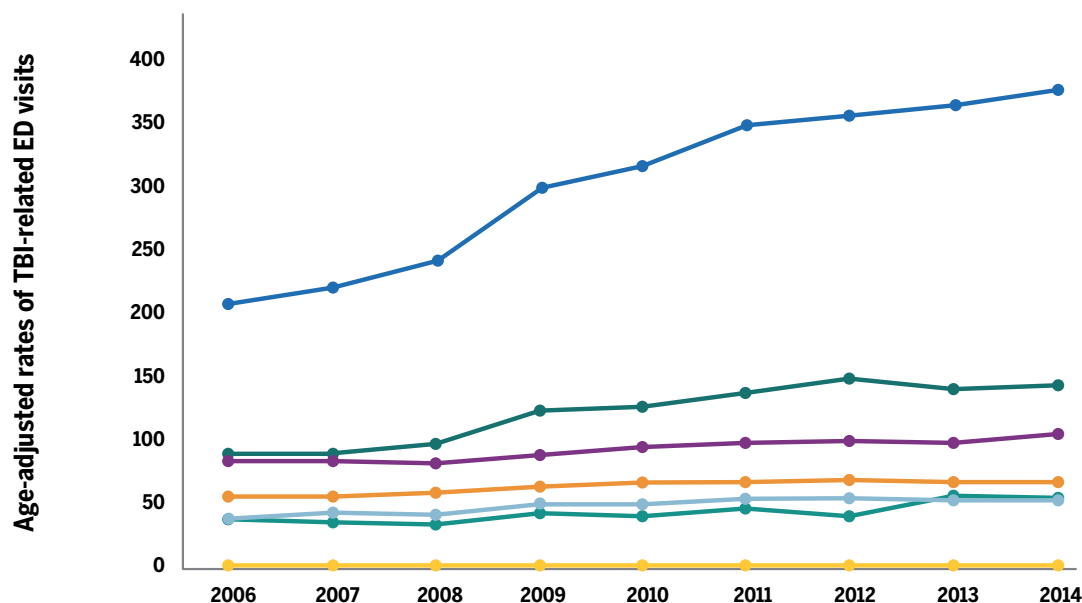
- The number of total TBI-EDHDS increased by 53% from 2006 (N approximately 1.88 million) to 2014 (N approximately 2.88 million).
- During this same time period the number of TBI-related ED visits increased by 63%, the number of TBI-related hospitalizations increased by 3.5%, and the number of TBI-related deaths increased by 4.3%.

### SOURCE

Healthcare Cost and Utilization Project's (HCUP) Nationwide Emergency Department Sample for emergency department visits; HCUP's Nationwide Inpatient Sample for hospitalizations; CDC's National Vital Statistics System for deaths.



FIGURE 2A: ESTIMATED AGE-ADJUSTED RATES<sup>†</sup>, PER 100,000 POPULATION, OF TRAUMATIC BRAIN INJURY–RELATED EMERGENCY DEPARTMENT VISITS, BY YEAR AND MECHANISM OF INJURY, 2006–2014



	2006	2007	2008	2009	2010	2011	2012	2013	2014
Motor vehicle crashes	85.3	83.8	83.9	88.7	95.3	98.7	99.9	99.6	106.0
Unintentional falls <sup>††</sup>	208.8	221.7	240.9	298.8	316.3	348.7	355.9	362.9	374.9
Unintentionally struck by or against an object	90.8	90.6	95.8	123.9	127.0	138.8	149.8	141.0	143.9
Other unintentional injury, mechanism unspecified <sup>††</sup>	40.4	42.7	43.1	49.5	50.5	53.4	55.4	54.1	53.2
Intentional self-harm	0.5	0.4	0.5	0.6	0.6	0.7	0.7	0.7	0.8
Assault	57.6	56.8	60.3	64.6	68.7	68.9	69.9	68.0	67.8
Other or no mechanism specified <sup>§§</sup>	38.2	37.7	35.3	44.2	41.1	47.1	40.4	58.3	55.3
Total	521.6	533.8	559.8	670.2	699.5	756.3	771.9	784.6	801.9

## Key Findings:

- Age-adjusted rates of TBI-related ED visits increased from 521.6 per 100,000 population in 2006 to 801.9 in 2014, representing nearly a 54% increase.
- This increase in age-adjusted rates of TBI-related ED visits occurred among nearly all of the major unintentional and intentional principal mechanism categories:
  - A 24% increase for TBIs as result of motor vehicle crashes (from 85.3 to 106, age-adjusted),
  - An 80% increase due to falls (from 208.8 to 374.9),
  - A 58% increase due to being struck by or against an object (from 90.8 to 143.9),
  - A 60% increase in intentional self-harm (from 0.5 to 0.8), and
  - An 18% increase due to assault (from 57.6 to 67.8).

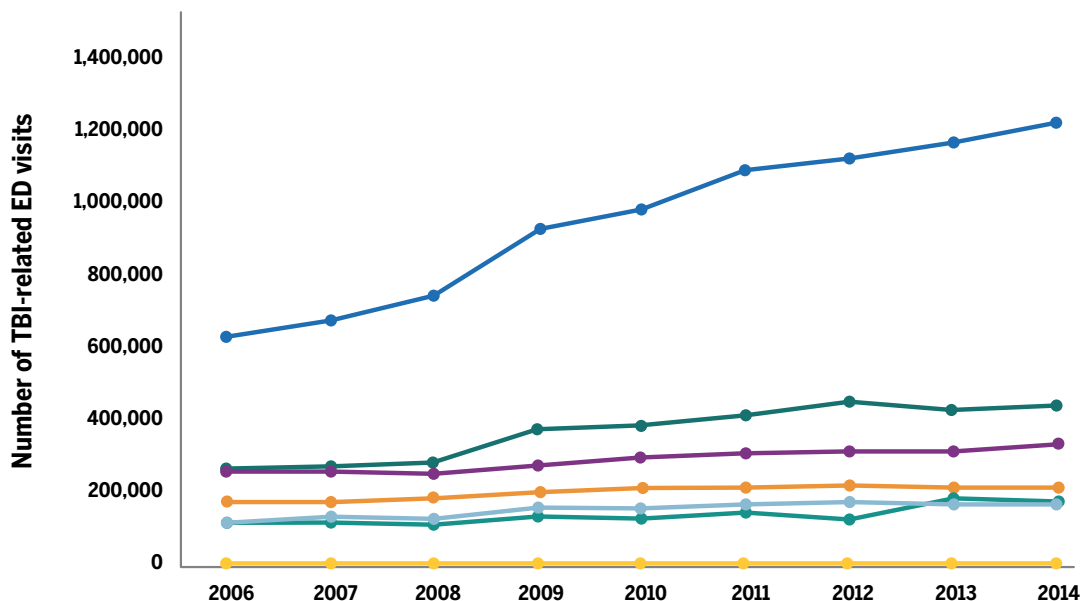
## SOURCE

Healthcare Cost and Utilization Project's (HCUP) Nationwide Emergency Department Sample.

<sup>†</sup>Age-adjusted to the 2000 U.S. standard population. <sup>††</sup>Includes falls of undetermined intent to maintain consistency with past data releases.

<sup>‡‡</sup>E-codes specify that the injury was unintentional but do not specify the actual mechanism of injury. <sup>§§</sup>Includes TBIs in which the intent was not determined as well as those due to legal intervention or war. Includes TBIs in which no mechanism was specified in the record. Does not include falls of undetermined intent.

**FIGURE 2B: ESTIMATED NUMBER OF TRAUMATIC BRAIN INJURY–RELATED EMERGENCY DEPARTMENT VISITS<sup>†</sup>, BY YEAR AND MECHANISM OF INJURY, 2006-2014**



	2006	2007	2008	2009	2010	2011	2012	2013	2014
Motor vehicle crashes	254,793	252,459	254,391	270,240	292,942	305,694	311,271	312,048	334,144
Unintentional falls <sup>††</sup>	625,098	672,504	740,528	928,049	980,245	1,090,575	1,120,041	1,163,473	1,213,476
Unintentionally struck by or against an object	266,268	267,175	284,297	369,348	379,601	415,408	447,591	423,477	433,951
Other unintentional injury, mechanism unspecified <sup>††</sup>	118,834	126,635	129,046	148,703	153,309	162,553	169,233	167,107	164,942
Intentional self-harm	1,401	1,254	1,425	1,669	1,807	2,029	2,214	2,284	2,567
Assault	171,327	169,638	181,246	195,231	209,062	210,772	214,776	210,220	210,469
Other or no mechanism specified <sup>§§</sup>	113,386	113,460	107,392	134,646	126,166	145,268	125,041	181,668	172,988

## Key Findings:

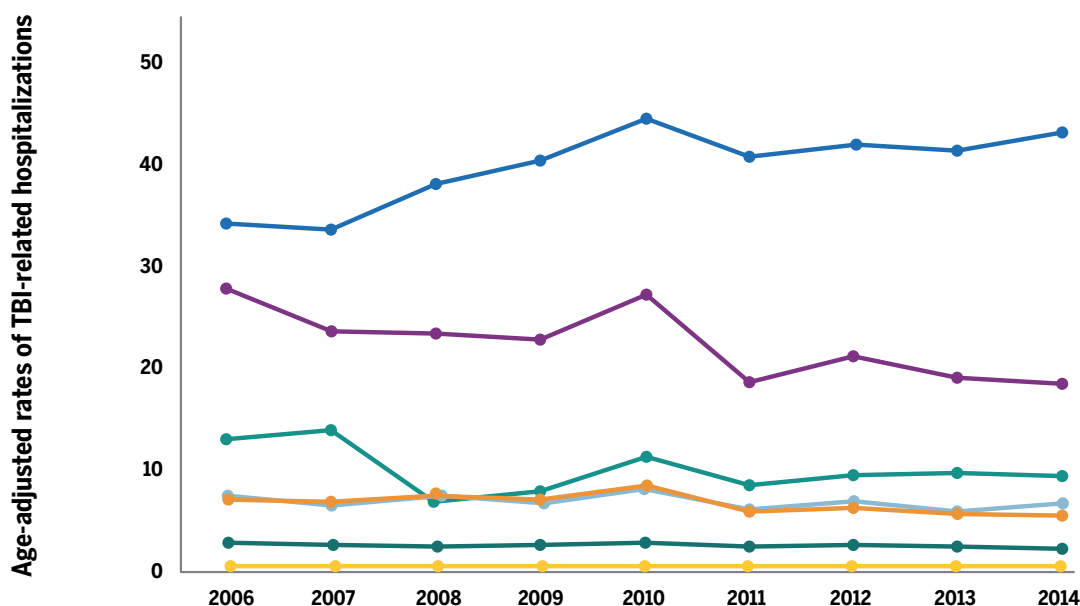
- The number of TBI-related ED visits increased by 63% from nearly 1.6 million in 2006 to 2.5 million in 2014.
- This increase in the number of TBI-related ED visits occurred among nearly all of the major unintentional and intentional principal mechanism categories, including a:
  - 31.1% increase for TBIs as result of motor vehicle crashes,
  - 94.1% increase for falls, 68% increase in being struck by or against an object,
  - 83.2% increase in intentional self-harm, and
  - 52.6% increase in assault.

## SOURCE

Healthcare Cost and Utilization Project's (HCUP) Nationwide Emergency Department Sample.

<sup>††</sup>Includes falls of undetermined intent to maintain consistency with past data releases. <sup>##</sup>E-codes specify that the injury was unintentional but do not specify the actual mechanism of injury. <sup>§§</sup>Includes TBIs in which the intent was not determined as well as those due to legal intervention or war. Includes TBIs in which no mechanism was specified in the record. Does not include falls of undetermined intent.

FIGURE 3A: ESTIMATED AGE-ADJUSTED RATES<sup>†</sup>, PER 100,000 POPULATION, OF TRAUMATIC BRAIN INJURY–RELATED HOSPITALIZATIONS, BY YEAR AND MECHANISM OF INJURY, 2006–2014



## Key Findings:

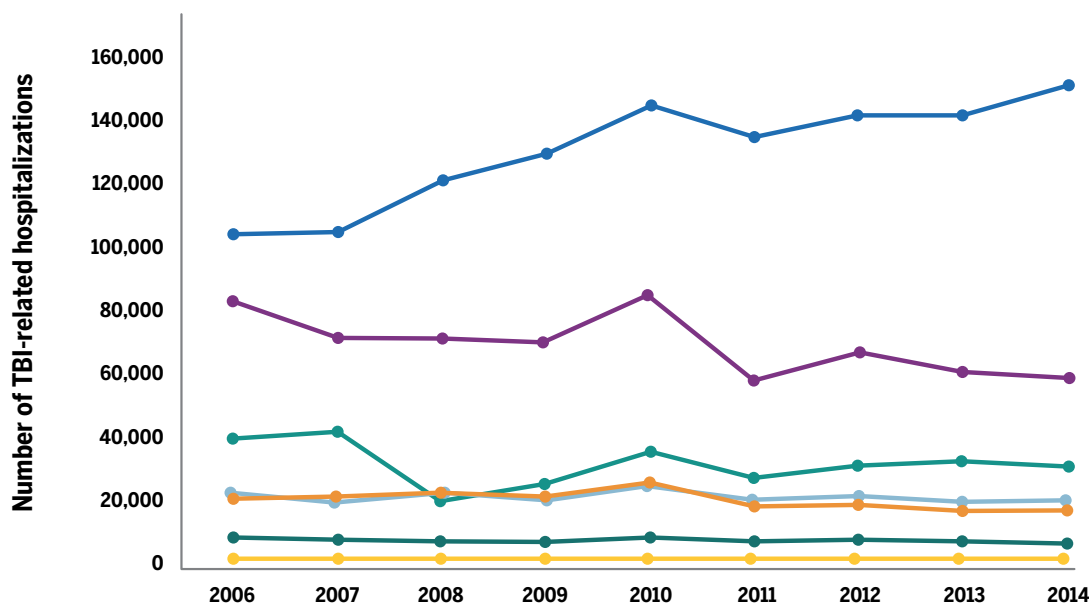
- From 2006 to 2014, age-adjusted rates of TBI-related hospitalizations decreased by nearly 8% (from 92.2 per 100,000 population to 84.9).
- This decrease coincides with a 34% decrease in the age-adjusted rate of TBI-related hospitalizations attributable to motor vehicle crashes (27.6 in 2006 to 18.1 in 2014).
- Despite the overall decrease in TBI-related hospitalization rates, there were increases in the age-adjusted rates of TBI-related hospitalizations attributable to falls (33.9 in 2006 to 42.9 in 2014) and intentional self-harm (0.4 in 2006 to 0.6 in 2014).

## SOURCE

Healthcare Cost and Utilization Project's (HCUP) Nationwide Inpatient Sample.

<sup>†</sup>Age-adjusted to the 2000 U.S. standard population. <sup>††</sup>Includes falls of undetermined intent to maintain consistency with past data releases. <sup>‡‡</sup>E-codes specify that the injury was unintentional but do not specify the actual mechanism of injury. <sup>§§</sup>Includes TBIs in which the intent was not determined as well as those due to legal intervention or war. Includes TBIs in which no mechanism was specified in the record. Does not include falls of undetermined intent.

**FIGURE 3B: ESTIMATED NUMBER OF TRAUMATIC BRAIN INJURY–RELATED HOSPITALIZATIONS<sup>‡</sup>, BY YEAR AND MECHANISM OF INJURY, 2006-2014**



	2006	2007	2008	2009	2010	2011	2012	2013	2014
Motor vehicle crashes	82,873	71,274	71,468	70,039	84,324	58,115	66,755	60,465	58,795
Unintentional falls <sup>††</sup>	103,608	104,319	120,775	129,456	144,854	134,771	141,620	141,855	150,745
Unintentionally struck by or against an object	8,126	7,684	7,577	7,659	8,815	7,218	7,885	7,010	7,090
Other unintentional injury, mechanism unspecified <sup>††</sup>	21,905	19,754	22,025	21,775	25,226	20,101	21,705	20,080	21,195
Intentional self-harm	1,339	1,293	1,235	1,351	1,778	1,395	1,655	1,665	1,730
Assault	21,270	20,648	22,405	21,873	25,355	18,562	19,545	17,520	17,395
Other or no mechanism specified <sup>§§</sup>	39,535	42,378	21,532	25,162	35,642	27,318	31,195	32,960	31,470

## Key Findings:

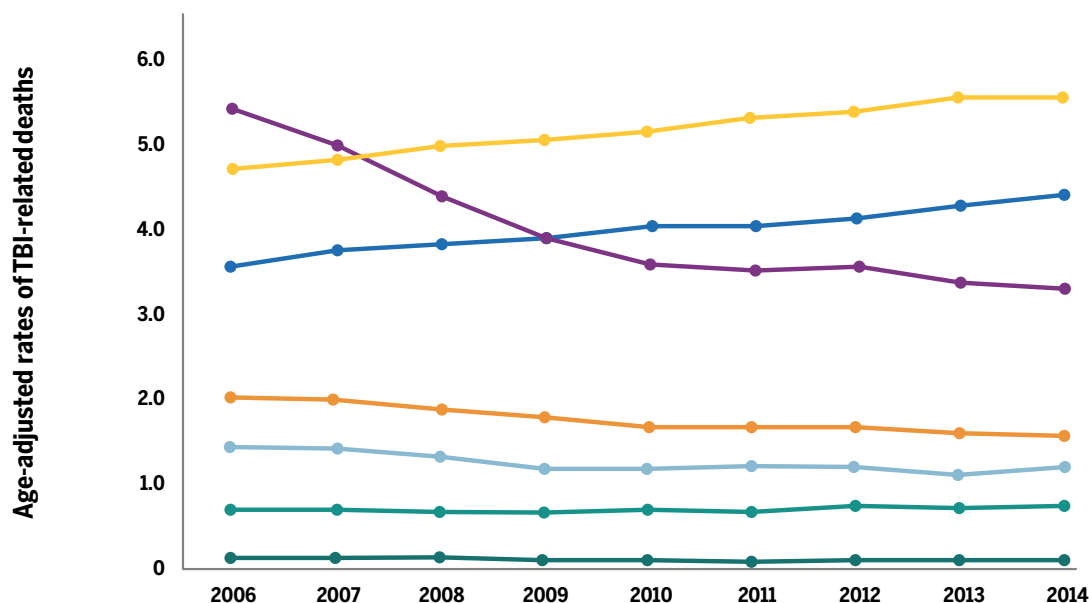
- The number of TBI-related hospitalizations increased by 3.5% from 278,655 in 2006 to 288,420 in 2014.
- From 2006 to 2014, the number of TBI-related hospitalizations attributable to motor vehicle crashes, unintentionally being struck by or against an object, and assault decreased by 29%, 12.7%, and 18.2%, respectively.
- During this same timeframe, the number of TBI-related hospitalizations attributable to unintentional falls and intentional assault increased by 45.5% and 29.2%, respectively.

## SOURCE

Healthcare Cost and Utilization Project's (HCUP) Nationwide Inpatient Sample.

<sup>††</sup>Includes falls of undetermined intent to maintain consistency with past data releases. <sup>‡‡</sup>E-codes specify that the injury was unintentional but do not specify the actual mechanism of injury. <sup>§§</sup>Includes TBIs in which the intent was not determined as well as those due to legal intervention or war. Includes TBIs in which no mechanism was specified in the record. Does not include falls of undetermined intent.

**FIGURE 4A: AGE-ADJUSTED RATES<sup>†</sup>, PER 100,000 POPULATION, OF TRAUMATIC BRAIN INJURY–RELATED DEATHS, BY YEAR AND MECHANISM OF INJURY, 2006-2014**



## Key Findings:

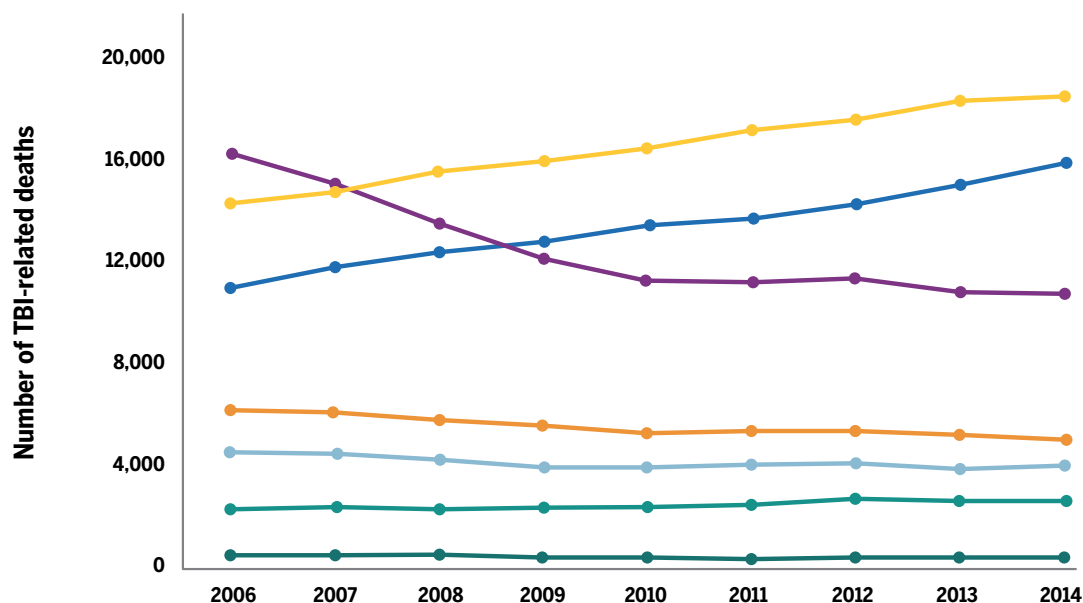
- From 2006 to 2014, age-adjusted rates of TBI-related deaths decreased by 6% (from 17.9 per 100,000 population to 16.8).
- This decrease coincides with a large decrease in the age-adjusted rate of TBI-related deaths attributable to motor vehicle crashes (5.4 in 2006 to 3.3 in 2014).
- From 2006 to 2014, age-adjusted rates of TBI-related deaths attributable to falls and intentional self-harm increased (from 3.6 to 4.4 and from 4.7 to 5.5, respectively).

## SOURCE

CDC's National Vital Statistics System.

<sup>†</sup>Age-adjusted to the 2000 U.S. standard population. <sup>††</sup>Includes falls of undetermined intent to maintain consistency with past data releases. <sup>‡‡</sup>E-codes specify that the injury was unintentional but do not specify the actual mechanism of injury. <sup>§§</sup>Includes TBIs in which the intent was not determined as well as those due to legal intervention or war. Includes TBIs in which no mechanism was specified in the record. Does not include falls of undetermined intent.

**FIGURE 4B: NUMBER OF TRAUMATIC BRAIN INJURY–RELATED DEATHS, BY YEAR AND MECHANISM OF INJURY, 2006-2014**



	2006	2007	2008	2009	2010	2011	2012	2013	2014
Motor vehicle crashes	16,260	15,080	13,490	12,074	11,235	11,136	11,314	10,781	10,656
Unintentional falls <sup>††</sup>	10,952	11,781	12,349	12,835	13,405	13,662	14,299	15,083	15,939
Unintentionally struck by or against an object	371	376	396	339	369	373	373	349	378
Other unintentional injury, mechanism unspecified <sup>††</sup>	4,335	4,371	4,163	3,774	3,814	3,891	3,948	3,772	3,889
Intentional self-harm	14,292	14,833	15,585	15,981	16,519	17,240	17,609	18,321	18,485
Assault	6,051	6,058	5,742	5,483	5,182	5,227	5,261	5,102	4,906
Other or no mechanism specified <sup>§§</sup>	2,172	2,200	2,100	2,181	2,313	2,308	2,578	2,513	2,547

### Key Findings:

- The number of TBI-related deaths increased by 4.3% from 54,433 in 2006 to 56,800.
- From 2006 to 2014, the number of TBI-related deaths attributable to motor vehicle crashes and homicide decreased by 34.4% and 18.9% respectively.
- During this same timeframe, the number of TBI-related deaths attributable to unintentional falls and intentional self-harm increased by 45.5% and 29.3%, respectively.

### SOURCE

CDC's National Vital Statistics System.

<sup>††</sup>Includes falls of undetermined intent to maintain consistency with past data releases. <sup>§§</sup>E-codes specify that the injury was unintentional but do not specify the actual mechanism of injury. <sup>§§</sup>Includes TBIs in which the intent was not determined as well as those due to legal intervention or war. Includes TBIs in which no mechanism was specified in the record. Does not include falls of undetermined intent.



# APPENDIX



## Methodological Appendix

To estimate the national incidence of TBI-related ED visits and hospitalizations, we analyzed 2014 data from the Healthcare Cost and Utilization Project's Nationwide Emergency Department Sample and National Inpatient Sample. HCUP is a suite of state-based administrative health care record databases and serves as a resource of encounter-level health care.<sup>2</sup> NEDS is the largest all-payer ED record database in the U.S. and when weighted it contains data on approximately 135 million ED visits.<sup>12</sup> During 2014, NEDS contained ED discharge data from 945 hospitals located in 33 states and the District of Columbia (D.C.). This sample represents a 20% stratified sample of U.S. hospital based EDs.<sup>12</sup> Similar to NEDS, NIS is the largest all-payer inpatient care record database in the U.S. and when weighted it contains data on approximately 35 million national hospital stays.<sup>13</sup> During 2014, NIS contained data from all states participating in HCUP and approximated a 20% stratified sample of hospitalizations from U.S. community hospitals, excluding long-term acute care and rehabilitation hospitals.<sup>13</sup> Weighting procedures for HCUP databases are outlined here.<sup>14-15</sup> For the 2006 to 2014 TBI trend analysis we used revised weights for NIS data from 2011 and earlier, due to the 2012 change in the sampling frame for this dataset. Information on the NIS data sampling frame change has been published elsewhere.<sup>1,16</sup>

Records from both NEDS and NIS do not include patient identifiers which creates the possibility that these datasets may contain more than one record per person. To reduce the possibility of counting multiple encounters for the same injury, specific records were excluded. Hospital transfers and admissions that occurred directly from the ED were excluded in ED counts as each would be captured in the hospitalization data. In-hospital deaths were excluded from hospitalization counts because these would be included in mortality data.

Counts of the national incidence of TBI-related deaths was performed by analyzing the multiple-cause-of-death files from the 2014 National Vital Statistics System (NVSS). NVSS captures data for all deaths registered in all 50 U.S. states and D.C.<sup>3</sup> Record-Axis Condition codes were used (usually included both Part I and Part II of Entity-Axis Condition codes) for statistical analysis of TBI-related deaths.

Estimated numbers of TBI-EDHDs are subject to rounding error due to records with missing age. However, this concern is reduced as less than 0.1% of ED and hospitalization records were missing age and 0% of mortality records were missing age during 2014. SAS version 9.3 (SAS Institute Inc., Cary, NC) was used for all statistical analyses.

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